

ROCK ISLAND DAM SMDLT MONITORING, 1991

by

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ABSTRACT

Downstream migrating salmon and steelhead trout (*Oncorhynchus* spp.) smolts were monitored at the Rock Island Dam bypass trap from 1 April - 31 August, 1991. This was the seventh consecutive year that the bypass trap was monitored. Data collected included: 1) number of fish caught by species, 2) number of branded fish caught by species, 3) daily average river-flow, 4) daily average powerhouse #1 and #2 flows and daily average spill. These data were transmitted to the Fish Passage Center, which manages the Smolt Monitoring Program throughout the Columbia River Basin. The Smolt Monitoring Program is used to manage the "water budget", releasing upstream water storage allocated to augment river flows to decrease migration timing of juvenile salmonids to the sea.

The Rock Island Dam trapping facility collected 104,855 downstream migrating salmonids in 1991. Collected fish included 424 chinook salmon (*O. tshawytscha*) and 710 steelhead (*O. mykiss*) which had been freeze branded (to determine migration rates) and 10,709 chinook and 14,078 steelhead with clipped adipose fins. The middle 80% of the 1991 spring migration (excluding sub-yearling chinooks) passed Rock Island Dam during a 34 day period, 5 May - 8 June. Passage rates of chinook and steelhead smolts released from hatcheries and the downstream migration timing of all salmonids are presented. The spring migration timing of juvenile salmonids is strongly influenced by hatchery releases above Rock Island Dam.

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INTRODUCTION

In 1982, the Northwest Power Planning Council developed a fish and wildlife program to protect, mitigate and enhance fish and wildlife resources affected by construction and operation of Columbia River hydroelectric facilities. Under this program, a “water budget” of allocated upstream water storage was established for instream flow augmentation to decrease migration timing of juvenile salmon and steelhead trout (*Oncorhynchus* spp.) on their journey to the ocean. The Council’s plan also called for studies to monitor juvenile fish migration timing and survival. The fishery agencies and tribes formed a Water Budget Center (renamed as the Fish Passage Center (FPC)) to direct the use of the water budget and to conduct and coordinate studies related to water budget management and evaluation. The FPC developed a Smolt Monitoring Program (SMP) and selected several sites on the Columbia and Snake rivers as smolt monitoring stations. Rock Island Dam was selected as one of these stations. It is the first dam located downstream from all of the major salmon and steelhead producing tributaries of the mid-Columbia River Basin (Figure 1).

The SMP for the mid-Columbia River was designed to index the daily number of outmigrating salmonids and to report numbers of marked juveniles collected. Data collected under this program allow comparison and evaluation of year to year migration timing and travel time of different stocks of juvenile salmonids, both hatchery and naturally produced.

Funding of the program, as implemented by the FPC, was provided by the Bonneville Power Administration. The Public Utility District No. 1 of Chelan County (the District) provided the trapping facility, personnel, and equipment to conduct the monitoring.

METHODS

Daily sampling data collected at the Rock Island Dam monitoring station included 1) total number of fish caught by species, 2) total number of branded fish caught by species, 3) daily average riverflow, 4) daily average flow through powerhouse #1 (old powerhouse) and powerhouse #2 (new powerhouse) (Figure 2), and daily average spill. The flow data were recorded so that an expanded index of fish passage through powerhouse #2 could be developed based on the bypass collection count in relation to the proportion of total riverflow passing through powerhouse #2.

Yearling and sub-yearling chinook (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) from state and federal hatcheries were freeze branded (using liquid nitrogen) before release. A comparison between the release date of marked smolts and daily recoveries at the bypass trap provided travel time estimates between release points and the dam. All hatchery produced steelhead released in Washington State waters since 1985 have been adipose fin clipped. Unmarked hatchery and naturally produced salmonids were also sampled to determine the timing of their migration past Rock Island Dam.

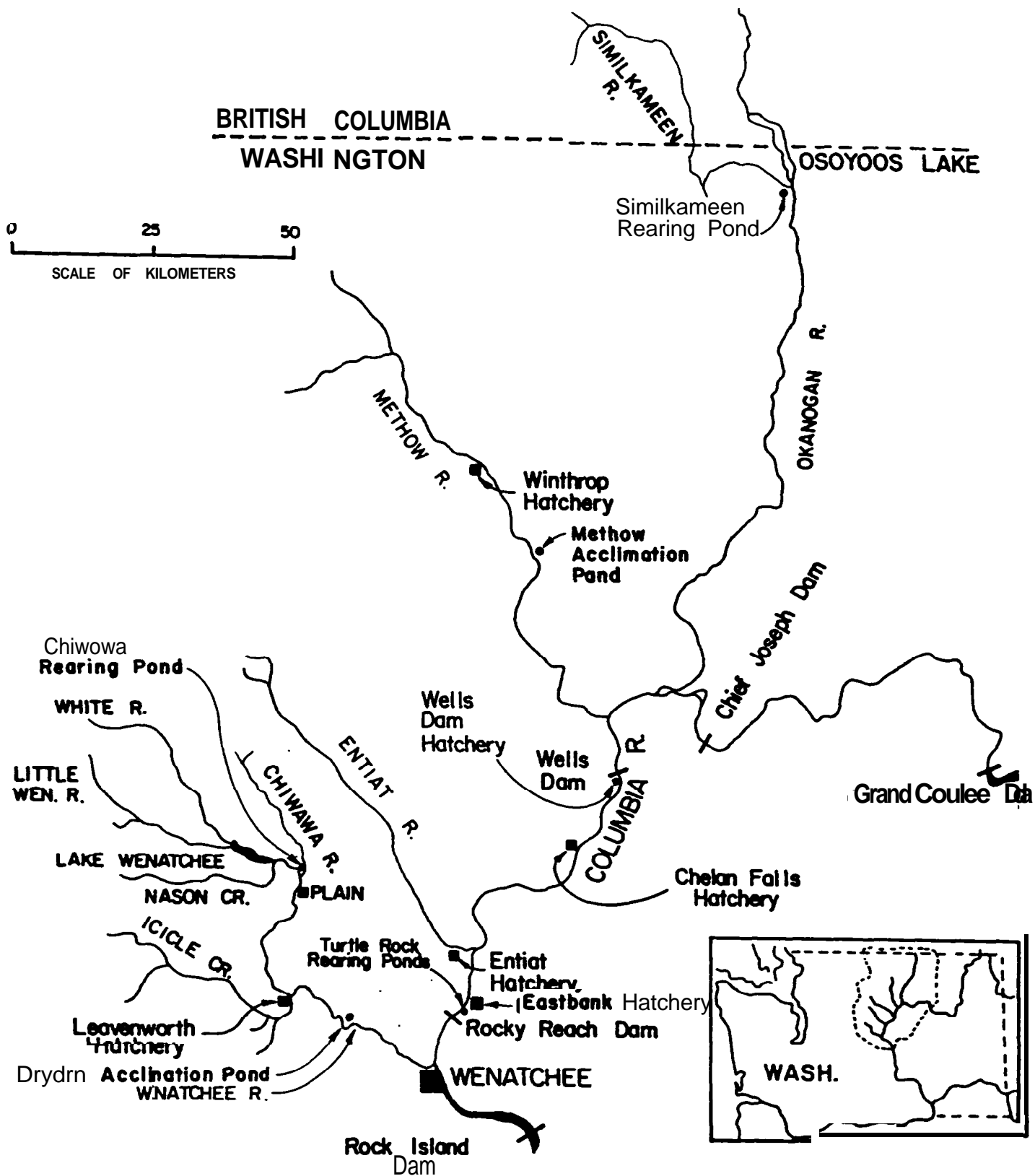


Figure 1. Columbia River between Rock Island and Grand Coulee dams showing major tributaries and hatcheries.

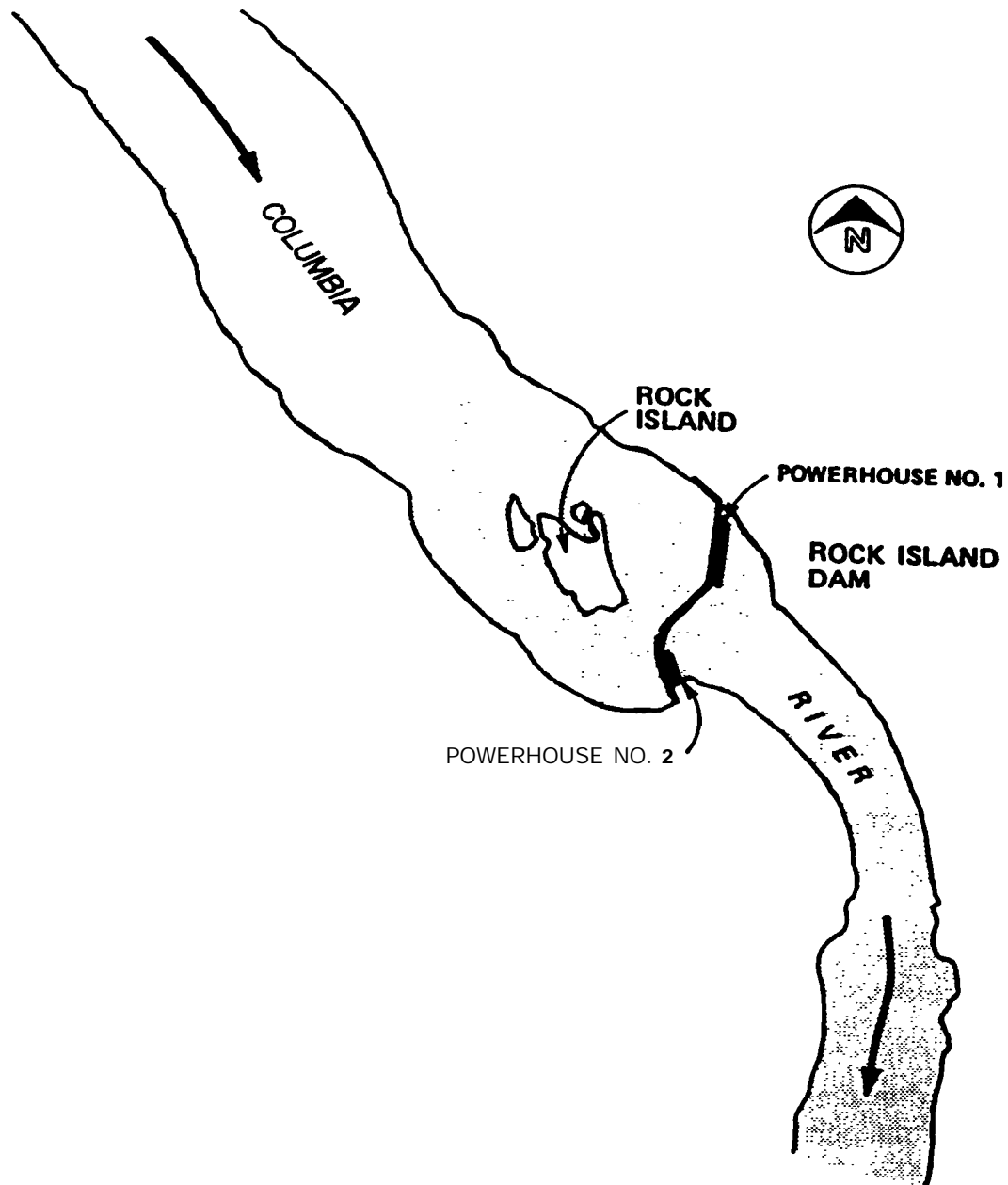


Figure 2. Location of powerhouse #1 and powerhouse #2 of Rock Island hydroelectric project.

Fish were collected from the second powerhouse turbine intake gatewells and fishway attraction water intake. Fish entering the gatewells and attraction water intake passed into a bypass channel through a series of submerged orifices (Figure 3). An inclined screen trap separated the fish from the 100 cfs bypass flow and confined them to a holding flume where they were retained for up to 24 hours before processing (Figure 4). All fish collected in the bypass channel were sampled.

Fish collected by the trap during the 24 hour sampling period (0900-0900) were crowded into an elevator hopper, raised to the upper deck of the dam, and released into an 12' x 4' x 3.5' aluminum holding tank (Figure 5). The holding tank was supplied with a continuous water flow from the right bank fishladder with a submersible pump.

Fish were "pre-anesthetized" before being dipped out of the aluminum tank, which was constructed with separate compartments for this purpose. Groups of 30-50 fish were then dip netted into a flume that passed into the processing trailer where they were further anesthetized with a solution of Tricaine Methane Sulfonate (MS 222) before handling. Fish were identified by species and examined for brands and clipped fins.

After the examined fish had fully recovered from the effects of the anesthesia, they were released through a 4" PVC pipe from the recovery section of the tank (elevation 620' m.s.l.) to the tailrace (elevation 574' m.s.l.) (Figure 5). The release area of the tailrace was protected from gull predation with parallel lengths of 80 pound test monofilament fish line tied at approximately 6 foot intervals overhead of the pipe outlet. In addition, an employee of the U. S. Department of Agriculture's Animal Damage Control Division suppressed gull foraging in the tailrace during the middle 80% of the spring migration by various behavior modifying techniques.

Data pertinent to the smolt monitoring program were transferred to the FPC (Portland, OR) daily via a personal computer that was located at the dam.

Fork length (FL) measurements were taken three times per week from subsamples of sockeye (*O. nerka*), and after 1 June, from sub-yearling chinook Steelhead were categorized as "hatchery" or "naturally-produced" according to clipped adipose fin, or if an adipose fin was present, a worn appearance of the dorsal and ventral fins (Peven and Hays 1989).

Because of new hatchery releases from our Eastbank Complex, a larger than average number of chinook yearlings were still passing the dam in mid- to late June. There was a length overlap of yearlings and sub-yearlings during this time. We collected length frequency information on all chinook captured at the bypass trap between 10 June and 22 July to attempt to separate yearlings and sub-yearlings. The FPC revised the numbers of yearlings and sub-yearlings between 16 June and 10 July based on length frequency of the sample compared to length frequencies of fish released from upstream hatcheries.

In addition to the smolt monitoring program, subsamples of chinook yearlings and steelhead were injected with Passive Integrated Transponder (PIT) tags each day between 19 April and 23 May. Equipment and procedures used in the PIT tagging operation were similar to

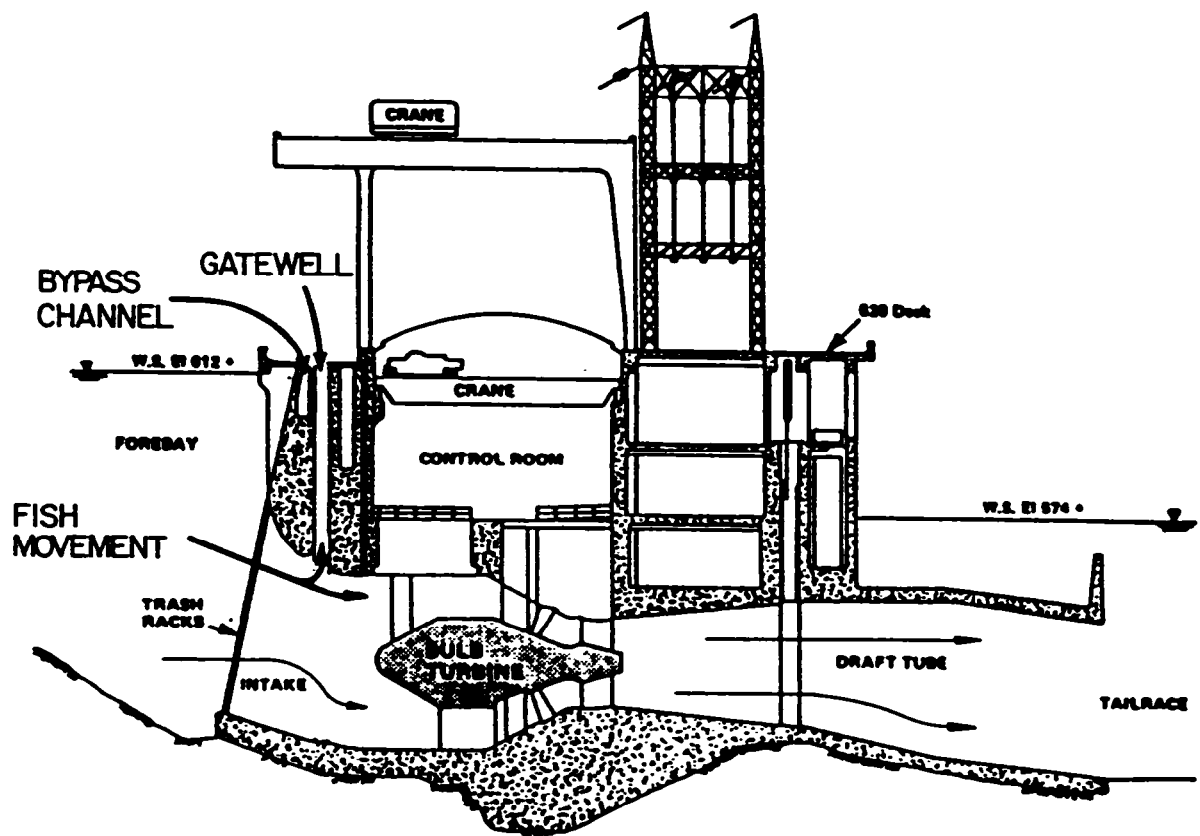


Figure 3. Section through Rock Island Dam second powerhouse indicating fish movement into gatewell system.

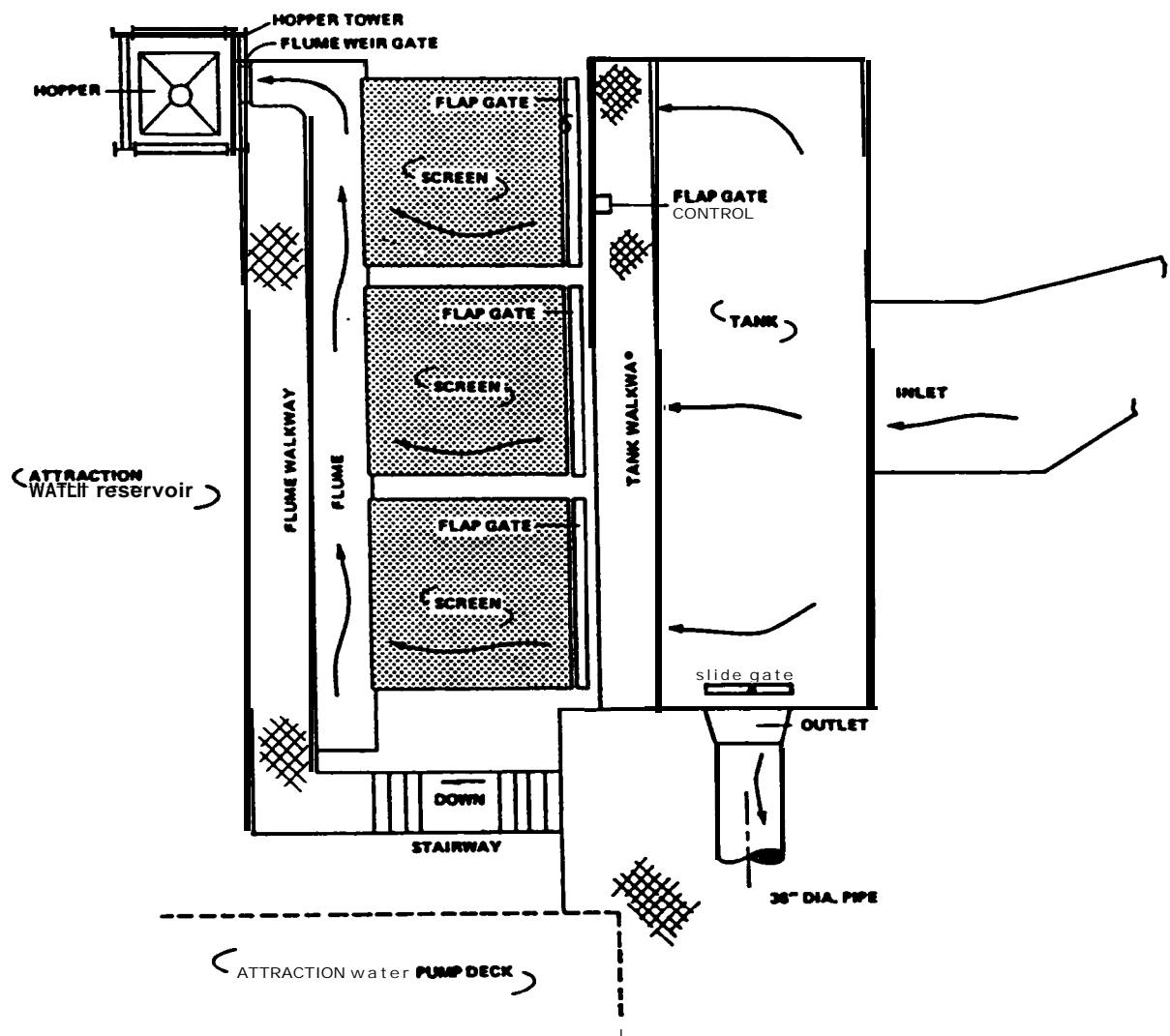


Figure 4. Rock Island Dam juvenile salmonid fingerling collection trap.

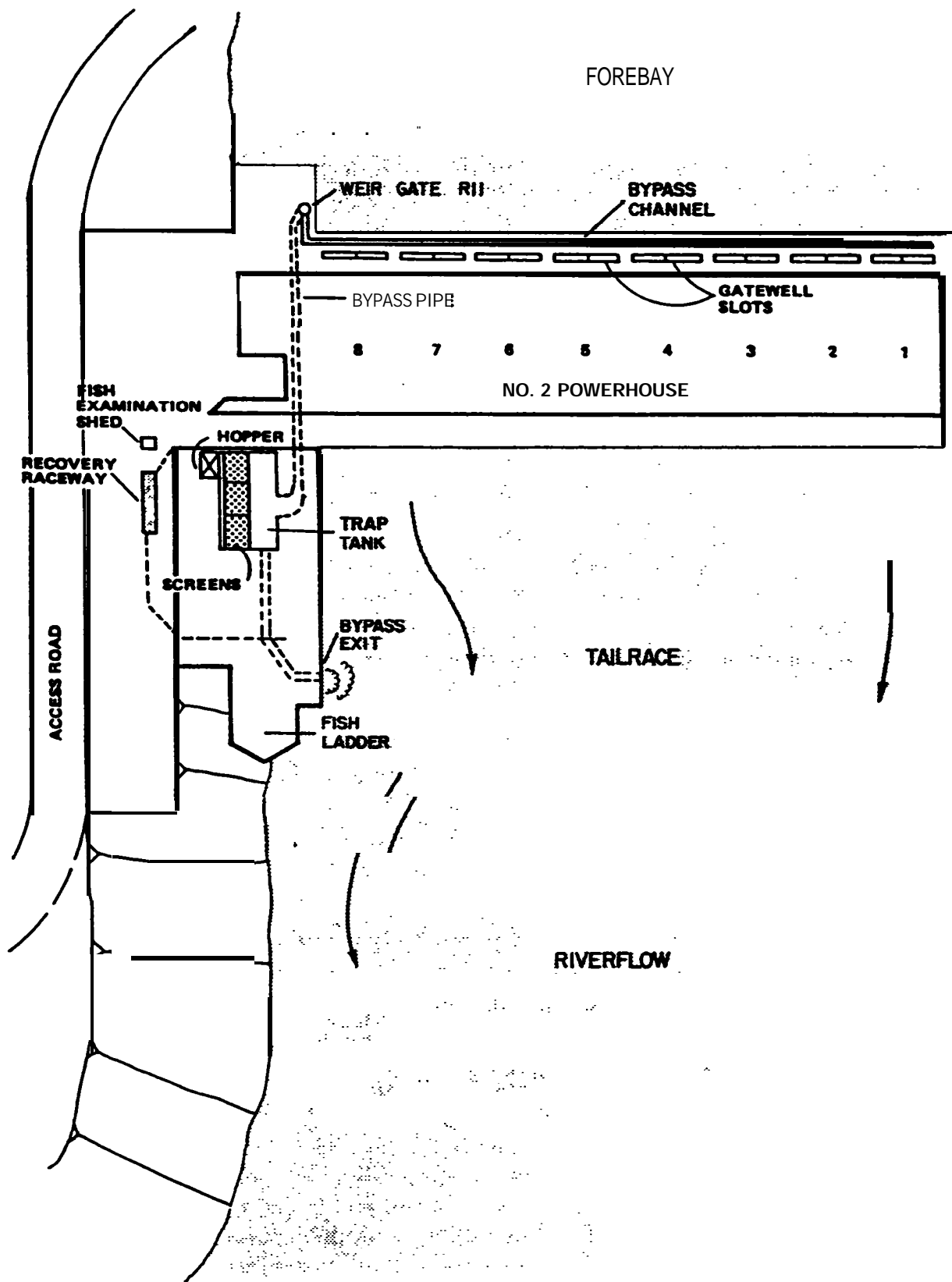


Figure 5. Plan view of juvenile salmonid bypass and collection system at Rock Island Dam second powerhouse (taken from Olson 1983).

the methods described by Prentice et al. (1987). A random subsample of chinook and steelhead were processed until 100 of each species were tagged each day. Data were entered into a portable computer and sent to the FPC daily. The fish that were PIT tagged at Rock Island Dam were "recaptured" at the McNary Dam bypass trap, where travel time estimates were recorded. Results of the PIT tagging program will be reported by the FPC.

RESULTS AND DISCUSSION

The Rock Island Dam trapping facility collected 104,855 juvenile salmon and steelhead during the 1991 smolt monitoring program (Appendix A). A total of 424 freeze branded chinook salmon and 710 freeze branded steelhead trout, representing 14 distinct marks and releases, were collected and recorded during 1991 (Table 1). In addition, we collected 10,709 chinook and 14,078 steelhead with clipped adipose fins.

The bypass trapping facility operated without mechanical failure during the smolt monitoring program. However, in mid April, there were a large number of dead fish entering the flume of the fish trap. Upon examining weir gate R-11 (Figure 5), we discovered the brushes that helped seal the sides of the gate were worn. On the afternoon of 24 April, we began dewatering the bypass channel to repair the brushes on the gate. The bypass was shut down for approximately 24 hours, and consequently, no sample was taken on 25 April.

An examination of daily powerhouse #2 turbine flows in proportion to total river flow showed a variance in powerhouse operations during the period of peak salmonid outmigration. Monthly average percent of total flow through powerhouse #2 for the period of 1 April through 30 June ranged from 59.0 to 62.2 % and daily averages ranged from 50.8 to 75.5% (Table 2).

Average daily hydraulic data for Rock Island Dam were supplied to the FPC, which used it to develop an expansion of Rock Island trap data. The expansion was derived by multiplying the actual trap collection count by the inverse proportion of water passing through powerhouse #2 during the sampling period (i.e., $(\text{collection count} \times 100) / (\text{powerhouse \#2 flow} / \text{powerhouse \#1 flow} + \text{powerhouse \#2 flow} + \text{spill})$). A comparison of actual trap collection counts, the expanded index, and the six year average (1985 - 1990) of actual counts (Table 3) indicated some differences in the smolt run timing.

The largest difference in the run timing was a 20 day difference in the 50% passage date for chinook yearlings between the actual counts for 1991, and the 6 year average (Table 3). Other large differences occurred between the actual and 6 year average dates for the 90% passage date for chinook yearlings (18 days), the 10 and 50% passage dates for sockeye (15 and 16 days, respectively), the 10% passage date for total yearlings (14 days), and the 10% passage date for total salmonids (13 days - Table 3). We used actual count data in our analysis and discussion.

Table 1. Summary of brand recovery rates for yearling chinook, sub-yearling chinook, and steelhead trout from the Rock Island Dam bypass trap, 1 April - 31 August, 1991.

Species	Brand	Release date	Release site	Branded fish released	First recov. date	Last recov. date	10% recov. date	50% recov. date	90% recov. date	Number recov.	Percent recov.
<i>Chinook yearling</i>	RA/7C/1	Apr 4	Entiat R.	17,500	Apr 6	May 20	Apr 6	Apr 16	May 17	28	0.16
	RA/7C/3	Apr 4	Entiat R.	17,500	Apr 7	May 20	Apr 7	Apr 19	May 11	27	0.15
	LA/7N/1	Apr 17	Wenat. R.	17,000	Apr 19	Jun 7	Apr 20	May 4	May 18	47	0.28
	LA/7N/3	Apr 17	Wenat R.	17,000	Apr 19	May 23	Apr 19	May 6	May 19	36	0.21
	RD/7N/1	Apr 17	Wenat R.	17,000	Apr 19	May 20	Apr 19	May 7	May 17	38	0.22
	LD/7T/1	Apr 11	Methow. R	17,000	Apr 24	May 21	Apr 29	May 15	May 20	29	0.17
	RA/7T/1	Apr 11	Methow. R	17,000	Apr 18	May 25	May 4	May 16	May 21	21	0.12
	RA/7T/3	Apr 11	Methow R	17,000	Apr 16	May 29	May 3	May 16	May 22	30	0.18
	Total:			137,000						256	0.19
<i>Chinook sub-yearling</i>	RA/U/1	Jun 14	Wells Dam	35,000	Jun 27	Aug 8	Jun 30	Jul 8	Jul 22	83	0.24
	RA/U/3	Jun 14	Wells Dam	35,000	Jun 28	Jul 28	Jun 30	Jul 9	Jul 13	85	0.24
	Total:			70,000						168	0.24
<i>Steelhead</i>	LD/7F/1	Apr 22	Smklmn R.	20,000	May 9	May 23	May 9	May 13	May 17	285	1.43
	LD/7F/3	Apr 22	Smklmn R.	20,000	May 9	May 27	May 10	May 13	May 17	269	1.35
	RA/7F/1	Apr 22	Methow R.	15,000	May 9	May 24	May 9	May 12	May 18	79	0.53
	RA/7F/3	Apr 22	Methow R.	15,000	May 9	May 24	May 9	May 13	May 16	77	0.51
	Total:			70,000						710	1.01
<i>Grand totals:</i>	14			277,000						1,134	0.41

**Table 2 Rock Island Dam powerhouse operations expressed in KCFS and percent streamflow,
1 April - 31 August, 1991 (monthly ranges appear in parentheses).**

	Average KCFS				
	April	May	June	July	August
Total river flow	168.8 (145.7-184.8)	178.0 (114.5-220.2)	181.2 (121.4-206.8)	156.0 (112.7-201.3)	140.4 (106.1-173.5)
Powerhouse #1	50.0 (15.2-70.7)	29.9 (1.7-45.8)	54.6 (17.3-70.1)	44.1 (18.5-68.6)	36.4 (11.8-55.2)
Powerhouse #2	104.6 (90.5- 114.3)	103.6 (75.9-114.9)	108.6 (88.9-120.3)	101.2 (83.6-115.1)	99.9 (89.3-115.9)
spill	13.0 (0.0-41.9)	43.2 (26.5-61.1)	16.0 (4.0-55.8)	9.2 (3.9-47.6)	3.0 (0.0-10.6)
Average percent of total flow					
Powerhouse #1	29.7 (9.6-39.8)	16.0 (1.5-22.5)	29.3 (14.3-37.9)	27.2 (15.7-38.4)	25.1 (10.8-34.9)
Powerhouse #2	62.2 (54.2-73.2)	59.0 (51.3-75.5)	60.8 (50.8-81.5)	66.1 (51.5-79.8)	72.1 (60.7-88.2)
Spill	7.5 (0.0-24.0)	24.3 (15.4-34.0)	9.2 (22-27.4)	5.7 (2.2-23.9)	2.0 (0.0-6.4)

Table 3 Comparison of actual, expanded, and the 6 year average (actual counts) of fish counts for passage dates for the Rock Island Dam bypass trap, 1991.

Species		Totals	Numbers			Date		
			10%	50%	90%	10%	50%	90%
<i>Chinook</i> <i>yearling</i>	Actual	31,645	3,165	15,823	28,481	Apr 29	May 27	Jun 12
	Expanded	54,682	5,468	27,341	49,214	Apr 30	May 28	Jun 12
	6 year avg.	20,117	2,012	10,059	18,106	Apr 20	May 7	May 23
<i>Chinook</i> <i>sub-yring</i>	Actual	22,019	2,202	11,010	19,817	Jun 5	Jul 9	Aug 9
	Expanded	34,448	3,445	17,224	31,003	Jun 4	Jun 7	Aug 9
	6 year avg.	29,849	2,985	14,924	26,864	Jun. 3	Jul 3	Aug 2
<i>Steelhead</i>	Actual	17,307	1,730	8,654	15,567	May 5	May 14	May 25
	Expanded	27,819	2,782	13,910	25,037	May 5	May 14	May 26
	6 year avg.	24,027	2,403	12,014	21,625	May 5	May 18	May 31
<i>Coho</i>	Actual	24,746	2,475	12,373	22,271	May 21	May 28	Jun 1
	Expanded	45,770	4,577	22,885	41,193	May 21	May 28	Jun 1
	6 year avg.	23,595	2,359	11,797	21,235	May 14	May 22	May 30
<i>Sockeye</i>	Actual	9,138	914	4,569	8,224	Apr 30	May 14	May 28
	Expanded	15,091	1,502	7,546	13,582	Apr 30	May 14	May 28
	6 year avg.	19,647	1,965	9,823	17,682	Apr 15	Apr 30	May 30
<i>Total</i> <i>yearlings</i>	Actual	82,836	8,284	41,418	74,552	May 5	May 24	Jun 8
	Expanded	143,362	14,336	71,681	129,026	May 5	May 25	Jun 7
	6 year avg.	87,335	8,734	43,668	78,602	Apr 21	May 17	May 29
<i>Total</i> <i>salmonids</i>	Actual	104,855	10,486	52,428	94,370	May 6	May 28	Jul 11
	Expanded	177,810	17,781	88,905	160,029	May 7	May 28	Jul 11
	6 year avg.	117,185	11,719	58,593	105,467	Apr 23	May 21	Jul 11

I. MIGRATION TIMING

Yearling chinook

A total of 31,645 chinook yearlings were captured at the bypass trap in 1991 (App. A). Yearling chinook were present the first day of the smolt monitoring program, 1 April, and continued to be present every day until 16 July (App. A). The last yearling chinook was collected on 24 August (App. A). The 10 and 90% passage dates for yearling chinook were 29 April and 12 June, respectively. Peak passage of 1,615 yearling chinook occurred on 11 June, approximately one month later than the peak passage date for the six year average (App. B-1). The 90% passage date of chinook yearlings in 1991 was 18 days later than the 6 year average, while the 10% passage date was 9 days later than the 6 year average and the 50% passage date was 20 days later than the 6 year average. (Table 3, App. B-1). The later passage dates for chinook yearlings in 1991 was probably due to the new releases of chinook yearlings from the Eastbank Hatchery Complex.

Sub-yearling chinook

A total of 22,019 chinook sub-yearlings were captured at the bypass trap in 1991 (App. A-6). Peak passage of 1,022 sub-yearling chinook occurred on 9 August. The 10 and 90% passage dates were 5 June and 9 August, respectively, while the 50% passage date for sub-yearling chinook was 9 July (Table 3, App. B-2). Fork length measurements were taken from sub-yearling chinook between 1 June and 16 August. These measurements show the mode difference between hatchery and naturally production (Figure 6).

Steelhead

A total of 17,307 steelhead smolts were collected at the bypass trap in 1991 (App. A-6). Daily collection of steelhead smolts began on 1 April and continued until 14 July, after which, steelhead were intermittently collected in low numbers (C 10) through August. Peak passage of 1,520 steelhead occurred on 13 May, one day before the 50% passage date. The 10 and 90% passage dates were 5 May and 25 May, respectively (Table 3, App. B-3), which was exactly the same for the 10% date, and six days earlier for the 90% date for the 6 year average.

Since 1989, rainbow trout that were released into Lake Roosevelt (above Grand Coulee Dam) have been collected at the Rock Island Dam bypass trap. These fish were of obvious hatchery origin, because of the condition of their dorsal fins, and were included in the number of hatchery steelhead sampled per day, even though they all had adipose fins present. Positive identification of these fish was possible because some of the fish were tagged (Al Scholz, pers. comm.). For the period between 19 April and 18 July, 519 Lake Roosevelt rainbow trout were captured.

Fork length measurements were obtained while PIT tagging and are presented in Figure 7. Steelhead fork length measurements have been recorded since 1986 to index the size difference between hatchery and naturally produced components of the run. Hatchery fish comprised approximately 81% of the steelhead juveniles recorded at the bypass trap in 1991,

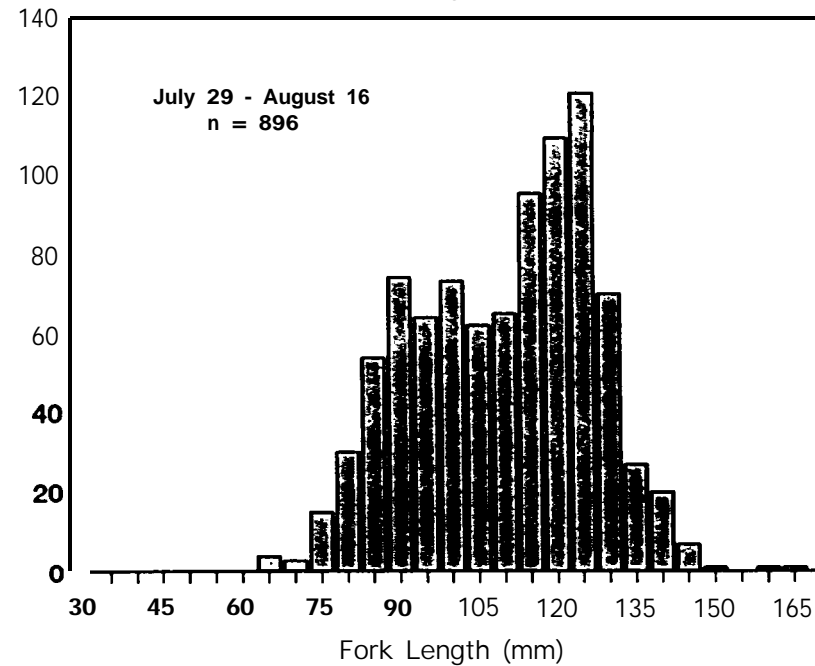
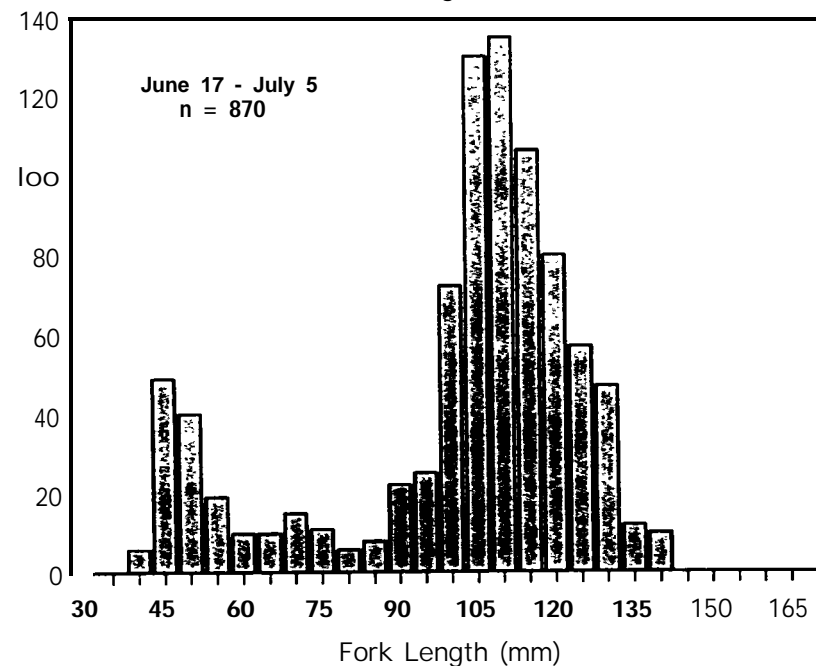
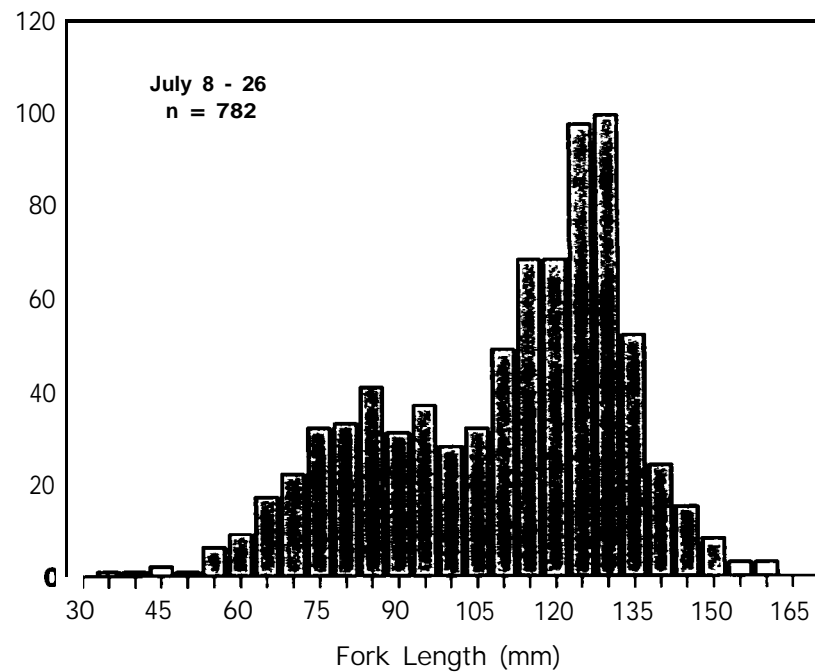
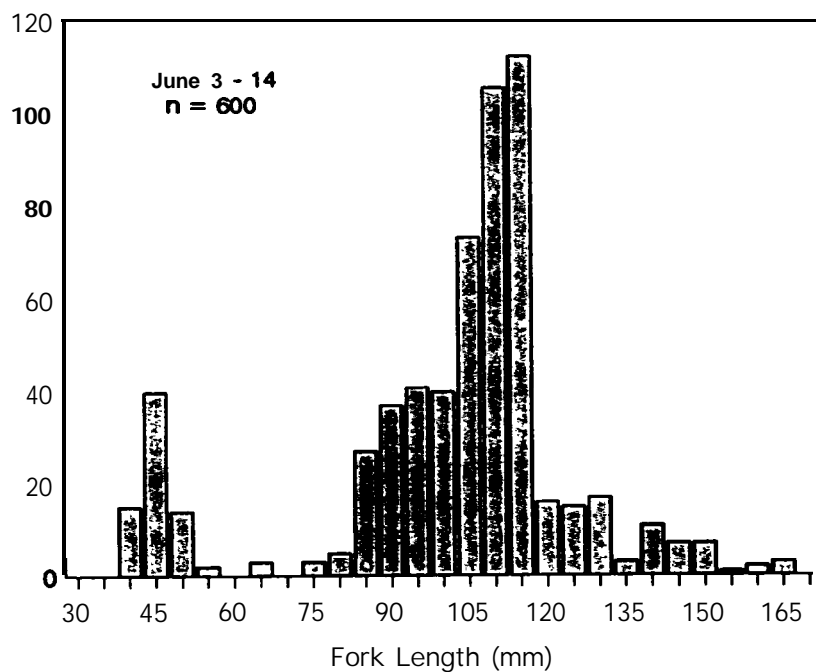


Figure 6. Length frequency histograms of sub-yearling chinook salmon, collected at Rock Island Dam bypass trap, 1991.

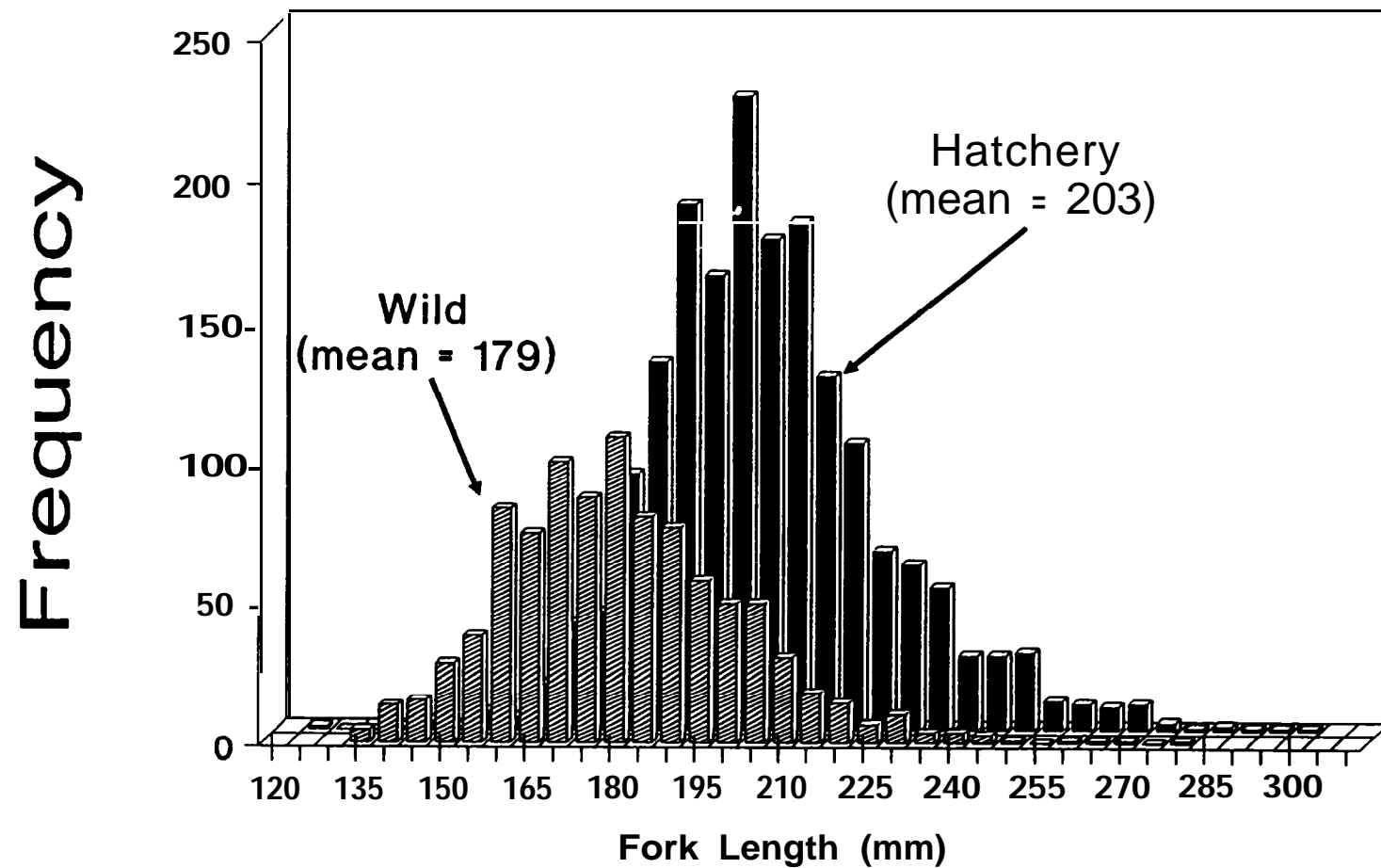


Figure 7. Length frequency histograms of hatchery and naturally produced steelhead trout smolts collected at the Rock Island Dam bypass trap, 1991.

however the proportion of hatchery fish is biased upward because Lake Roosevelt rainbow trout were included in the samples (see above).

Sockeye

A total of 9,138 sockeye smolts were collected at the bypass trap in 1991 (App. A-6). Sockeye smolts were present at Rock Island Dam on the first day of the monitoring program, 1 April. The last sockeye smolt was trapped on 22 August. Peak passage occurred on 14 May when 662 sockeye smolts were collected. The 10 and 90% passage dates were 30 April and 28 May, respectively, while 50% of the outmigrating sockeye smolts had passed Rock Island Dam by 14 May (Appendix B-4).

Juvenile sockeye usually pass Rock Island Dam in a bimodal run timing because of the two stocks of that pass on their seaward migration (Okanogan and Wenatchee rivers). Wenatchee River outmigrants pass Rock Island Dam primarily in April and Okanogan River smolts are more prevalent at Rock Island Dam in May (Peven 1987).

Length frequencies were taken from sockeye smolts between 22 April and 29 May (Figure 8). Length frequency data has been collected from sockeye smolts since 1986 to distinguish between the two stocks that migrate past the dam, with the Okanogan stock generally being larger than the Wenatchee stock (Peven 1987).

This year we saw 721 sockeye that were extremely large (> 275 mm FL), that were not included in the daily catch. We believe that because of the large size of these individuals, these fish are kokanee that escaped from Lake Roosevelt or other lakes upstream. In 1989, otoliths were taken from approximately 15 fish that were already dead when found in the bypass trap. The age readings that we obtained from the otoliths showed that these fish were between 3 and 5 years old, suggesting they were probably kokanee, not sockeye. We also took scales samples from the sockeye run at large this year. We observed fish that were 230 mm FL that were classified as kokanee (J. Sneva, WDF, pers. comm.).

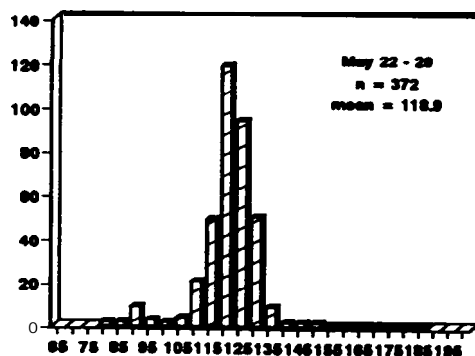
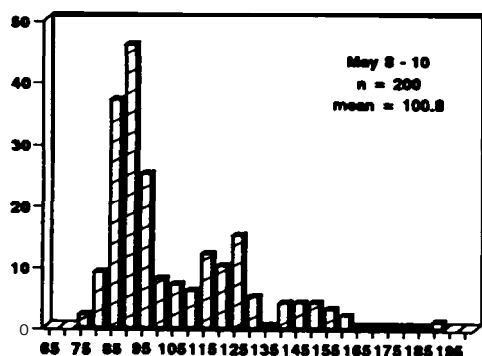
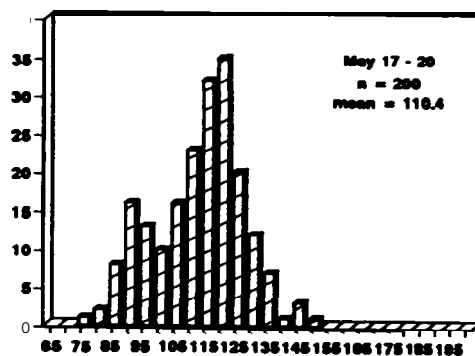
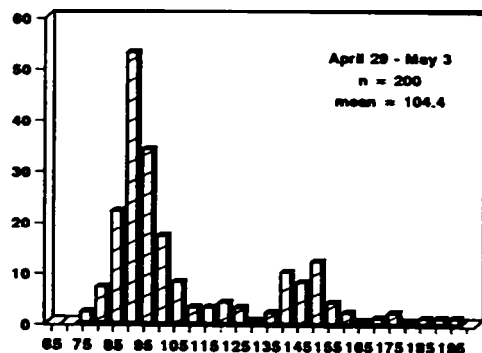
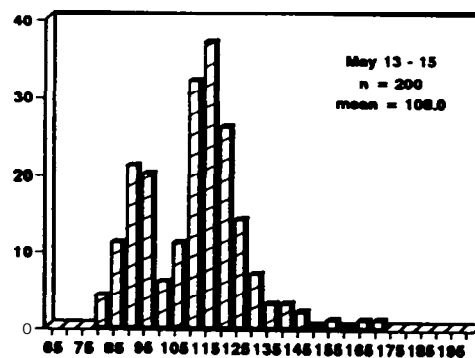
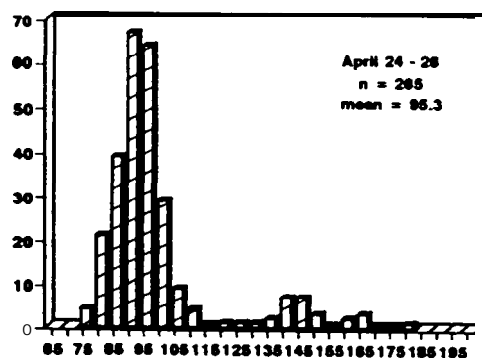
Coho

A total of 24,746 coho (*O. kisutch*) were captured at the bypass trap in 1991 (App. A-6). Daily presence of coho smolts began on 8 May and continued until 15 June (App. A). The last coho was collected on 8 August. Peak passage of 3,054 coho smolts occurred on 29 May (Appendix A-2, B-5). The 10, 50, and 90% passage dates for coho were 21, 28 May, and 1 June, respectively. The 10, 50, and 90% passage dates for coho in 1991 were 7, 6, and 1 day(s), respectively, later than the 6 year average (Table 3, App. B-4).

Total salmonid run

A total of 104,855 juvenile salmonids were collected at the bypass trap in 1991. The total salmonid run timing is represented in Appendix B-6. The peak passage count of 4,039 on 29 May was largely influenced by the large collection of coho ($n = 3,054$ - App. A).

Frequency



Fork Length (mm)

Figure 8. Length frequency histograms of sockeye smolts collected at the Rock Island Dam bypass trap, 1991.

The effect of sub-yearling chinook was assessed on the 10, 50, and 90% dates for the total cumulative juvenile salmonid migration. A comparison was made between 1991 and the previous six year average (1985 - 1990) between the total juvenile outmigration past Rock Island Dam and the outmigration excluding sub-yearling chinook (Figure 9). The duration of the middle 80% of the total juvenile salmonid passage (10% date to 90% date) was 66 days, 6 May to 11 July with a 50% passage date on 28 May, compared to a 79 day duration for the 6 year average, with 10, 50, and 90% passage dates: 23 April, 21 May, and 11 July, respectively (Table 3, Figure 9). Excluding sub-yearling chinook from this analysis results in a spring migrant run duration of 34 days, 5 May to 8 June, with a 50% passage date on 24 May, compared to a 38 day duration for the six year average, with 10, 50, and 90% passage dates: 21 April, 17 May, and 29 May, respectively (Table 3, Figure 9). The extension of the 50 and 90% passage dates for chinook yearlings (see above) is believed to be the dominant factor affecting the run timing in 1991.

In summary, in 1991, sub-yearling chinook extended the juvenile migration 90% passage date 32 days: from 8 June (spring migration) to 11 July (total migration). Run timing in 1991 was 13 days shorter than the six year average. The middle 80% of the total juvenile salmonid migration past Rock Island Dam in 1991 was 66 days compared to 79 days for the six year average. Excluding sub-yearlings from this comparison, the spring migration past the dam in 1991 was 34 days.

During April and May this year, we collected eight Atlantic salmon (*Salmo solar*). These fish are believed to be escapees from a net pen operation above Chief Joseph Dam, operated by Sea Farms of Washington.

II. MARKED FISH RECOVERIES

Fourteen groups of freeze branded hatchery fish totaling 277,000 fish (Table 1) were released into the Columbia River system upstream from Rock Island Dam. These fish were marked and released to evaluate the relationships between Columbia River flow rates and travel time. These releases consisted of 137,000 chinook yearlings, 70,000 sub-yearling chinook, and 70,000 steelhead. Table 1 presents information concerning these releases as well as recovery data, including: first, last, 10, 50, and 90% recovery dates and the number and percent recapture of each release group.

Leavenworth National Fish Hatchery

Yearling chinook

The first branded fish were recovered at Rock Island Dam on 19 April, from fish released 17 April. The 50% recovery date at Rock Island Dam for the 3 groups of Leavenworth branded yearling spring chinook were 4, 6, and 7 May, resulting in a median travel time of 17, 19, and 20 days, respectively (Table 1). The last branded chinook from Leavenworth was recovered on 7 June. The Rock Island Dam bypass trap sampled 0.21 - 0.28% of the fish from these brand groups (Table 1). These fish entered the Columbia River 15 miles

Numbers of Fish (1000's)

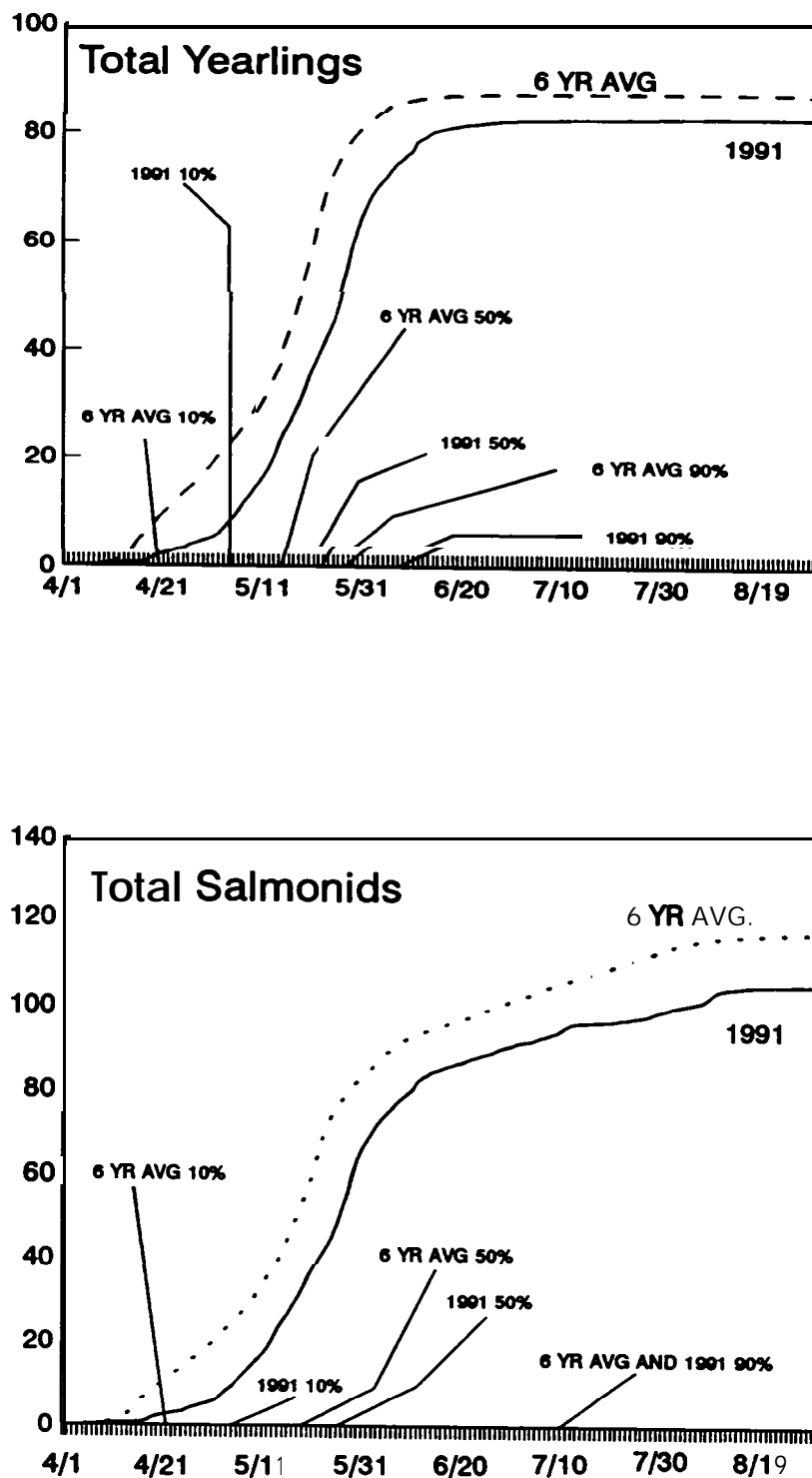


Figure 9. Comparison of cumulative total juvenile salmonid (total salmonid) passage at Rock Island Dam between 1991 and the six year average and a comparison of the cumulative juvenile migration excluding subyearling chinook (total yearlings) for 1991 and the six year average.

above Rock Island Dam and, as a result, Columbia River flows had less influence on travel time to Rock Island Dam for these groups compared to fish released above Rocky Reach Dam.

Winthrop National Fish Hatchery

Yearling chinook

Three groups of yearling chinook were released into the Methow River on 11 April (Table 1). The median passage times for the three groups of fish were 36, 37, and 37 days. The Rock Island Dam bypass trap sampled 0.12 - 0.18% of these released groups (Table 1).

Entiat National Fish Hatchery

Yearling chinook

Two groups of yearling chinook were released into the Entiat River on 4 April. The median passage date for these groups were 12 and 15 days (Table 1). We sampled 0.15 and 0.16% of these two groups, respectively (Table 1).

Wells Dam Fish Hatchery (WDF and WDW)

Sub-yearling chinook

Two groups of branded sub-yearling chinook were released from Wells Dam on 14 June. The median travel time to Rock Island Dam for these two groups was 11 days and the bypass trap collected 0.24% of the marked fish from these releases (Table 1). These fish had a shorter travel distance than the yearling chinook released in the Methow River.

Steelhead

Marked steelhead were released on 22 April into the Methow and Similkameen rivers (Table 1). Median travel times of both groups released in the Similkameen River were 21 days. The median travel times for the two groups released into the Methow River were 20 and 21 days (Table 1). Steelhead migrated downstream faster than did chinook yearlings traveling approximately the same distance (Methow releases). We recovered 1.35 and 1.43% of the steelhead released from the Similkameen releases. For the Methow releases, we recovered only 0.51 - 0.53% of the fish released. Personnel at Rock Island Dam noticed that most of the branded steelhead observed at the dam had poor quality brands. These brands appeared too deep (burned) into the body of the fish and probably will reduce the number of fish that would survive to return as adults.

SUMMARY

Between 1 April and 31 August, 1991, 104,855 downstream migrating salmonids were collected at the Rock Island Dam bypass trap. Freeze branded fish collected consisted of

424 chinook salmon and 710 steelhead trout. In addition, 10,709 chinook and 14,078 steelhead were collected that had clipped adipose fins.

The middle 80% of the salmonid outmigration passed Rock Island Dam between 6 May and 11 July, 1991, a 66 day period. The dates and duration of the outmigration were extended by sub-yearling chinook in 1991. If sub-yearling chinook are excluded from analysis, the middle 80% of the outmigration was 5 May to 8 June, a 34 day period. Sub-yearling chinook comprised 21% of the fish collected at Rock Island Dam in 1991.

ACKNOWLEDGMENTS

This monitoring effort was funded by the Bonneville Power Administration, U.S. Department of Energy, as a part of the Northwest Power Planning Council's program to protect, mitigate, and enhance fish and wildlife affected by hydroelectric facilities in the Columbia River Basin. The study was coordinated through the Fish Passage Center. Dave Marvin, Larry Basham, and Tom Breggren of the FPC were very helpful throughout the study. Dave Marvin of FPC assisted in the PIT tagging program. John Sneva of the Washington Department of Fisheries read the juvenile sockeye scales. Chelan County PUD conducted the smolt monitoring at Rock Island Dam and a number of District employees assisted with the study. Dick Nason, Steve Hays, and Paul Fielder provided administrative and logistical help as well as information and advice. The following individuals assisted with the trap monitoring and data input into the computer: Barry Keese, Eric Gocke, Robert McDonald, Keith Truscott, Shane Bickford, Todd West, Nancy Duree, and Carolyn Moldrem.

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Appendix A

Daily salmonid catch, Rock Island Dam bypass trap, 1 April - 31 August

Appendix A-1. Daily salmonid catch, Rock Island bypass trap, April, 1991.

DATE	CHINOOK	CHINOOK	STEELHEAD			COHO	SCKEYE	TOTAL	TOTAL
	YEARLINGS	SUBYEAR	WILD	HATCHERY	TOTAL			SALMONID	YEARLING
01-Apr	3	4	1	0	1	0	1	9	5
02-Apr	3	3	2	0	2	0	2	10	7
03-Apr	6	1	2	0	2	0	2	11	10
04-Apr	1	4	2	0	2	0	0	7	3
05-Apr	3	2	2	0	2	0	0	7	5
06-Apr	59	3	8	0	8	0	0	70	67
07-Apr	86	1	5	0	5	0	0	92	91
08-Apr	113	1	2	0	2	0	0	116	115
09-Apr	73	1	6	0	6	0	2	82	81
10-Apr	81	2	6	0	6	0	1	90	88
11-Apr	27	3	2	0	2	0	5	37	34
12-Apr	28	5	2	0	2	0	1	36	31
13-Apr	21	3	0	0	0	0	1	25	22
14-Apr	11	6	5	1	6	0	0	23	17
15-Apr	16	5	3	0	3	0	2	26	21
16-Apr	28	4	0	0	0	0	3	35	31
17-Apr	41	6	4	1	5	0	4	56	50
18-Apr	336	3	6	42	48	0	8	395	392
19-Apr	569	2	8	40	48	0	9	628	626
20-Apr	374	7	4	26	30	0	20	431	424
21-Apr	139	0	6	16	22	0	40	201	201
22-Apr	173	4	4	31	35	0	72	284	280
23-Apr	97	2	3	27	30	0	95	224	222
24-Apr	104	1	4	41	45	0	176	326	325
25-Apr	0	0	0	0	0	0	0	0	0
26-Apr	381	5	11	69	80	0	143	609	604
27-Apr	229	2	21	58	79	0	75	385	383
28-Apr	142	8	30	51	81	0	111	342	334
29-Apr	168	12	28	59	87	0	103	370	358
30-Apr	110	4	21	84	105	0	56	275	271
								0	0
Totals:	3,422	104	198	546	744	0	932	5,202	5,098

Appendix A-2. Daily salmonid catch, Rock Island bypass trap, May, 1991.

DATE	Chinook	Chinook	STEELHEAD			COHO	SOCKEYE	Total	Total
	Yearlings	Subyear	WILD	HATCHERY	TOTAL			SALMONID	YEARLING
01-May	184	3	33	105	138	0	45	370	367
02-May	246	0	30	93	123	0	165	534	534
03-May	289	5	37	138	175	0	602	1,071	1,066
04-May	344	9	43	260	303	1	485	1,142	1,133
05-May	314	1	50	286	336	5	276	932	931
06-May	436	0	35	355	390	2	414	1,242	1,242
07-May	381	1	69	475	544	0	454	1,380	1,379
08-May	386	1	61	481	542	6	225	1,160	1,159
09-May	313	4	68	832	900	24	171	1,412	1,408
10-May	264	1	57	763	820	16	159	1,260	1,259
11-May	177	2	45	885	830	18	141	1,168	1,166
12-May	246	0	53	1,032	1,085	22	183	1,536	1,536
13-May	249	0	70	1,450	1,520	40	265	2,074	2,074
14-May	476	0	97	1,259	1,356	64	662	2,558	2,558
15-May	384	6	74	831	905	99	515	1,909	1,903
16-May	344	1	92	727	819	84	158	1,406	1,405
17-May	756	0	161	911	1,072	143	158	2,129	2,129
18-May	791	1	134	543	677	273	204	1,946	1,945
19-May	943	3	127	420	547	585	217	2,295	2,292
20-May	1,017	3	103	366	469	865	160	2,514	2,511
21-May	827	6	102	282	384	813	131	2,161	2,155
22-May	504	4	116	213	329	1,002	314	2,153	2,149
23-May	398	7	90	167	257	883	255	1,800	1,793
24-May	478	28	97	153	250	932	279	1,967	1,939
25-May	575	54	45	88	133	1,293	208	2,263	2,209
26-May	736	46	48	62	110	1,789	332	3,013	2,967
27-May	746	61	36	46	82	2,708	96	3,693	3,632
28-May	539	124	22	34	56	2,607	97	3,423	3,299
29-May	595	259	24	28	52	3,054	79	4,039	3,780
30-May	809	273	30	26	56	2,390	58	3,586	3,313
31-May	766	212	15	24	39	1,682	53	2,752	2,540
Totals:	15,513	1,115	2,064	13,235	15,299	21,400	7,561	60,888	59,773

Appendix A-3. Daily salmonid catch, Rock Island bypass trap, June, 1991.

D A T E	CHINOOK	CHINOOK	STEELHEAD			COHO	SOCKEYE	TOTAL	TOTAL
	YEARLINGS	SUBYEAR	W	I	L D	HATCHERY	TOTAL	SALMONID	YEARLING
01-Jun	851	92	12	28	40	1,024	48	2,055	1,963
02-Jun	824	87	28	17	45	867	58	1,881	1,794
03-Jun	779	213	40	27	67	567	39	1,665	1,452
04-Jun	790	332	39	17	56	328	54	1,560	1,228
05-Jun	530	273	44	26	70	186	38	1,097	824
06-Jun	1,020	290	34	14	48	145	39	1,542	1,252
07-Jun	898	292	38	27	65	85	22	1,362	1,070
08-Jun	618	206	18	26	44	40	15	923	717
09-Jun	687	283	26	24	50	21	23	1,064	781
10-Jun	628	178	21	34	55	17	16	894	716
11-Jun	1,615	189	25	27	52	12	19	1,887	1,698
12-Jun	565	269	18	28	46	20	18	918	649
13-Jun	395	152	16	25	41	9	12	609	457
14-Jun	610	115	21	21	42	7	6	780	665
15-Jun	218	74	13	11	24	3	4	323	249
16-Jun	206	176	22	14	36	0	8	426	250
17-Jun	210	224	21	14	35	3	4	476	252
18-Jun	99	204	16	22	38	5	6	352	148
19-Jun	117	214	12	7	19	1	3	354	140
20-Jun	152	139	9	5	14	0	0	305	166
21-Jun	133	356	5	9	14	0	2	505	149
22-Jun	68	345	13	2	15	0	3	431	86
23-Jun	45	329	8	7	15	1	0	390	61
24-Jun	93	275	12	8	20	1	4	393	118
25-Jun	82	217	12	5	17	0	4	320	103
26-Jun	98	203	10	1	11	1	1	314	111
27-Jun	89	498	13	11	24	1	2	614	116
28-Jun	32	383	13	10	23	0	2	440	57
29-Jun	21	308	15	4	19	0	0	348	40
30-Jun	18	221	18	7	25	0	1	265	44
Totals:	12,491	7,137	592	478	1,070	3,344	451	24,493	17,356

Appendix A-4. Daily **salmonid** catch, Rock Island bypass trap, July, 1991.

DATE	CHINOOK	CHINOOK	STEELHEAD			COHO	SOCKEYE	TOTAL	TOTAL
	YEARLINGS	SUBYEAR	WILD	HATCHERY	TOTAL			SALMONID	YEARLING
01-Jul	28	441	10	6	16	0	0	485	44
02-Jul	35	161	5	11	16	1	2	215	54
03-Jul	3	140	4	7	11	0	1	155	15
04-Jul	4	171	2	0	2	0	1	178	7
05-Jul	11	423	4	5	9	0	0	443	20
06-Jul	3	421	5	3	8	0	2	434	13
07-Jul	4	364	4	3	7	0	3	378	14
08-Jul	1	342	3	3	6	0	1	350	8
09-Jul	3	387	6	3	9	0	0	399	12
10-Jul	4	695	7	0	7	0	1	707	12
11-Jul	35	684	4	2	6	0	1	726	42
12-Jul	23	619	4	4	8	0	0	650	31
13-Jul	2	112	2	0	2	0	0	116	4
14-Jul	2	79	0	0	0	0	2	83	4
15-Jul	4	82	1	0	1	0	0	87	5
16-Jul	0	44	0	0	0	0	0	44	0
17-Jul	0	33	1	0	1	0	0	34	1
18-Jul	0	37	1	1	2	0	1	40	3
19-Jul	0	67	3	0	3	0	0	70	3
20-Jul	0	89	0	0	0	0	2	91	2
21-Jul	6	154	0	0	0	0	0	160	6
22-Jul	6	259	1	1	2	0	2	269	10
23-Jul	6	103	1	1	2	0	0	111	8
24-Jul	2	234	3	2	5	0	0	241	7
25-Jul	2	175	1	4	5	0	2	184	9
26-Jul	0	105	2	2	4	0	1	110	5
27-Jul	10	270	6	0	6	0	12	298	28
28-Jul	9	497	0	6	6	0	14	526	29
29-Jul	2	381	0	6	6	0	10	399	18
30-Jul	1	321	1	2	3	0	21	346	25
31-Jul	2	321	0	2	2	0	18	343	22
Totals:	208	8,211	81	74	155	1	97	8,672	461

Appendix A-5. Daily salmonid catch, Rock Island bypass trap, August, 1991.

DATE	CHINOOK	CHINOOK	STEELHEAD			COHO	SOCKEYE	TOTAL	TOTAL
	YEARLINGS	SUBYEAR	WILD	HATCHERY	TOTAL			SALMONID	YEARLING
01-Aug	0	309	2	4	6	0	13	328	19
02-Aug	0	295	2	0	2	0	3	300	5
03-Aug	0	241	0	5	5	0	10	256	15
04-Aug	0	215	1	0	1	0	13	229	14
05-Aug	1	228	2	1	3	0	1	233	5
06-Aug	2	245	1	1	2	0	2	251	6
07-Aug	0	241	0	3	3	0	6	250	9
08-Aug	0	720	0	2	2	1	13	736	16
09-Aug	4	1,022	0	1	1	0	16	1,043	21
10-Aug	1	687	1	2	3	0	1	692	5
11-Aug	1	277	0	0	0	0	4	282	5
12-Aug	0	226	0	2	2	0	4	232	6
13-Aug	1	117	2	0	2	0	1	121	4
14-Aug	0	128	0	0	0	0	3	131	3
15-Aug	0	106	0	1	1	0	2	109	3
16-Aug	0	98	2	0	2	0	2	102	4
17-Aug	0	29	0	0	0	0	0	29	0
18-Aug	0	46	1	0	1	0	0	47	1
19-Aug	0	46	0	0	0	0	0	46	0
20-Aug	0	22	0	0	0	0	1	23	1
21-Aug	0	28	0	0	0	0	0	28	0
22-Aug	0	38	0	0	0	0	1	39	1
23-Aug	0	22	1	0	1	0	0	23	1
24-Aug	1	23	0	0	0	0	0	24	1
25-Aug	0	10	0	0	0	0	0	10	0
26-Aug	0	12	0	0	0	0	0	12	0
27-Aug	0	8	0	0	0	0	0	8	0
28-Aug	0	3	0	0	0	0	0	3	0
29-Aug	0	1	0	0	0	0	1	2	1
30-Aug	0	4	1	0	1	0	0	5	1
31-Aug	0	5	1	0	1	0	0	6	1
Totals:	11	5,452	17	22	39	1	97	5,600	148

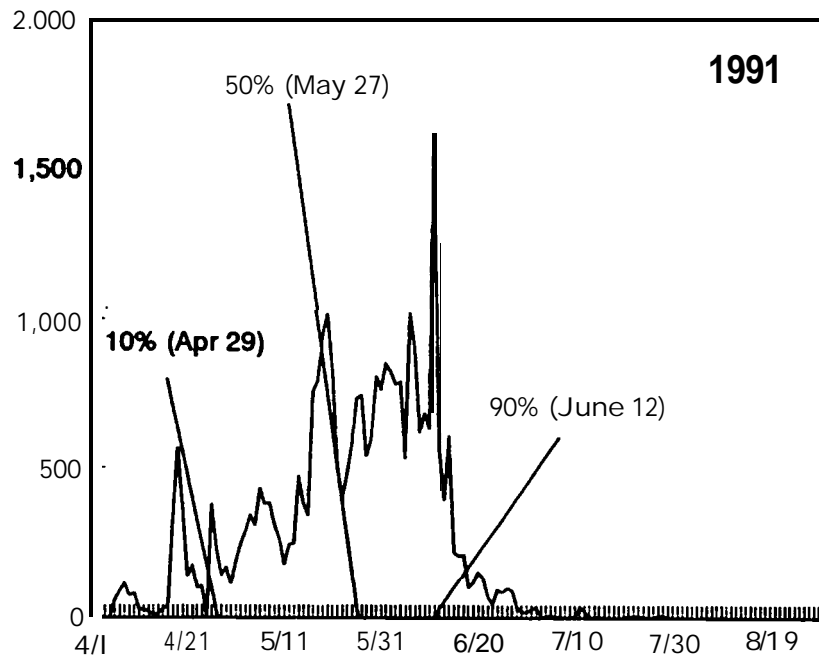
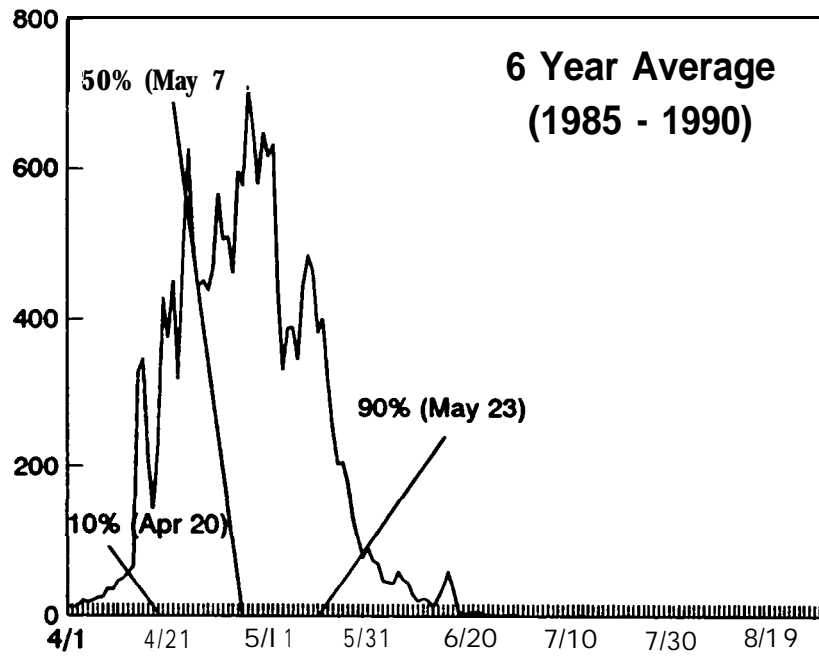
Appendix A-6. Monthly summary of the Rack Island bypass catch, 1 April - 31 August, 1991.

MONTH	CHINOOK	CHINOOK			TOTAL	COHO	SOCKEYE	TOTAL	TOTAL
	YEARLINGS	SUBYEAR	WILD	HATCHERY				SALMONID	YEARLING
APRIL	3,422	104	198	546	744	0	932	5,202	5,098
MAY	15,513	1,115	2,064	13,235	15,299	21,400	7,561	60,888	59,773
JUNE	12,491	7,137	592	478	1,070	3,344	451	24,493	17,356
JULY	208	8,211	81	74	155	1	97	8,672	461
AUGUST	11	5,452	17	22	39	1	97	5,600	148
TOTALS	31,645	22,019	2,952	14,355	17,307	24,746	9,138	104,855	82,836

Appendix B

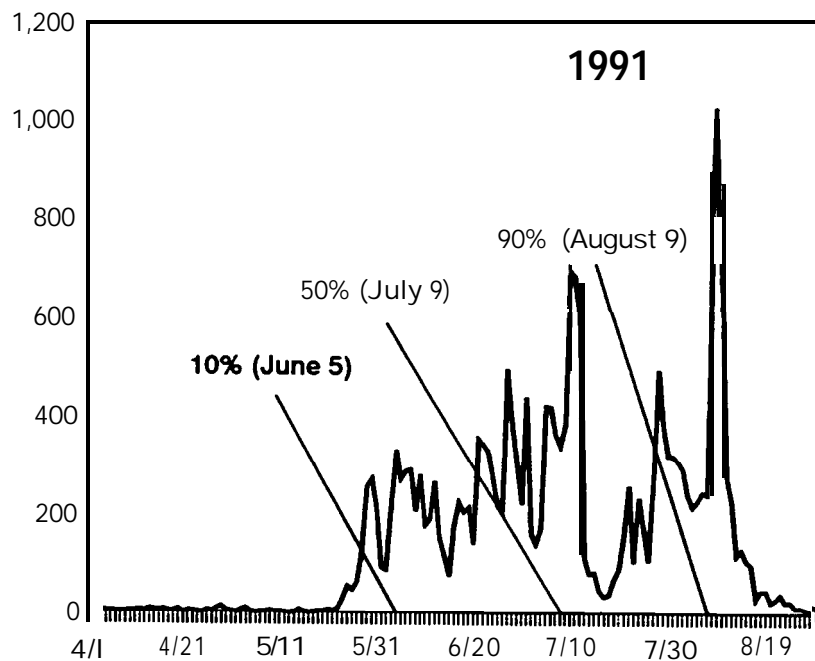
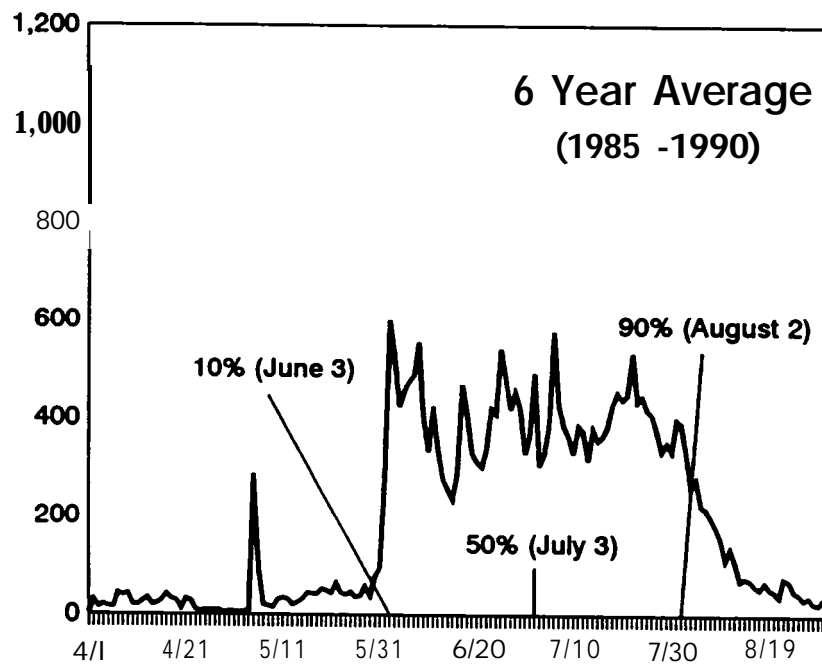
Daily juvenile salmonid run timing for 1991 and the 6 year average

Numbers of Fish/day

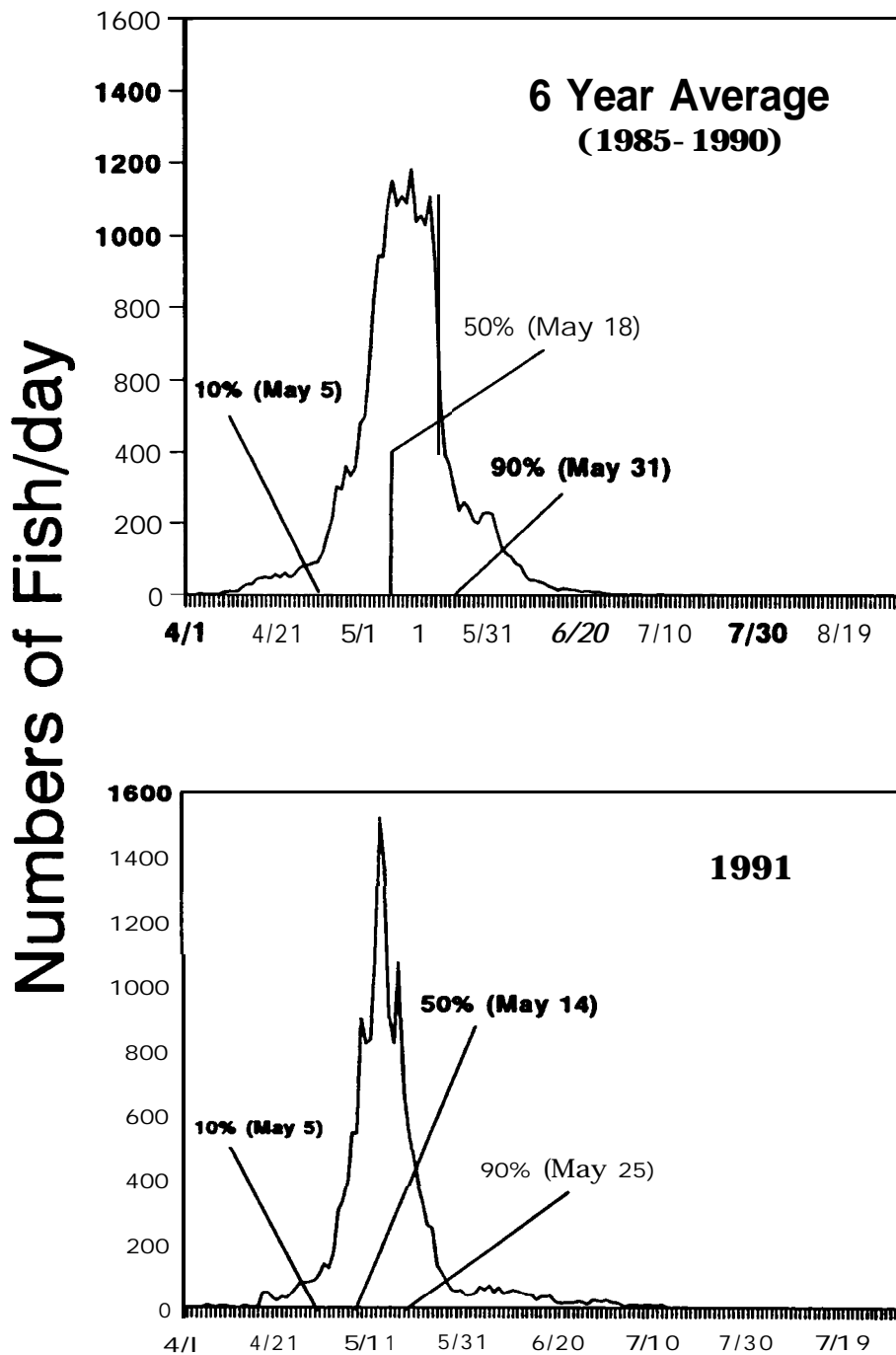


Appendix B-I. Chinook yearling juvenile run timing, Rock Island Dam, 1991 and the 6 year average.

Numbers of Fish/Day

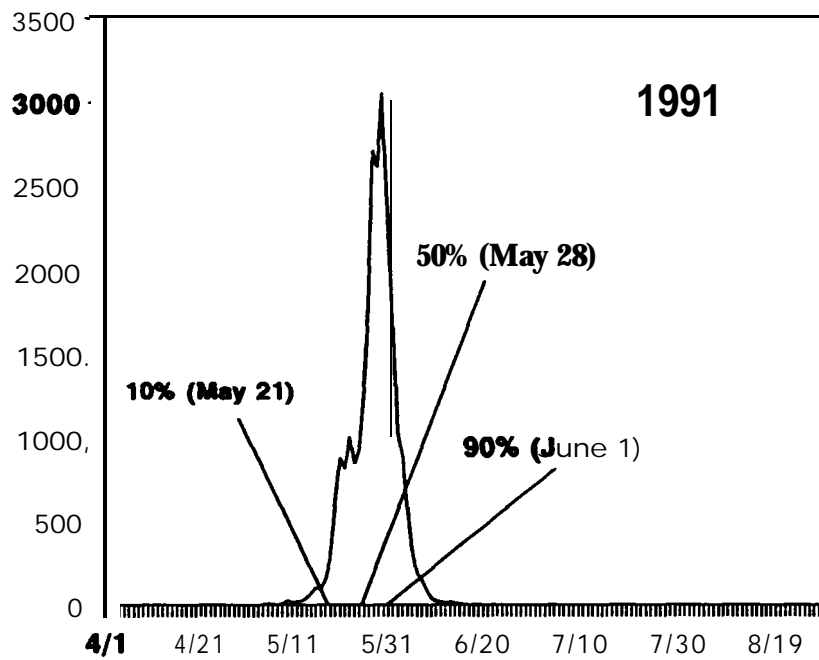
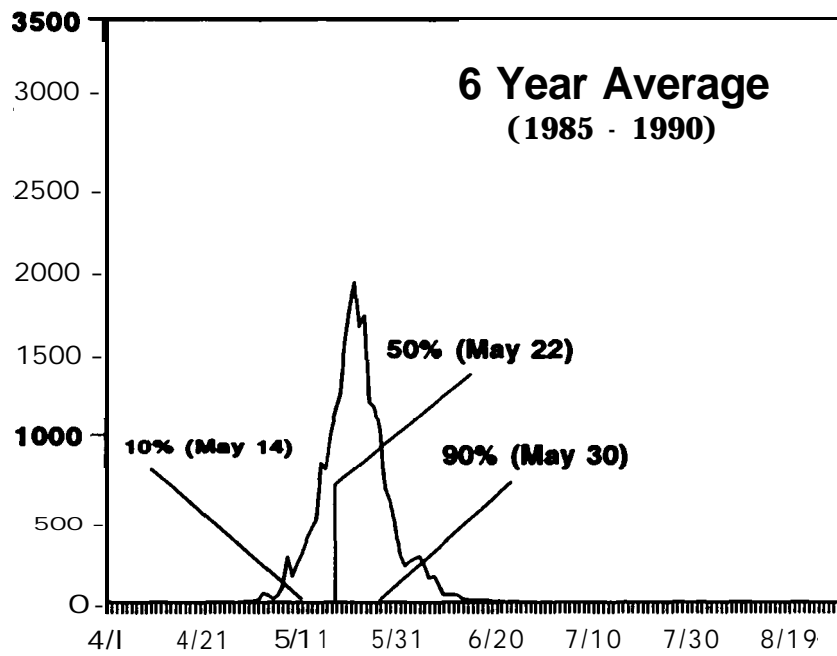


Appendix B-2. Chinook sub-yearling juvenile run timing, Rock Island Dam, 1991 and the 6 year average.



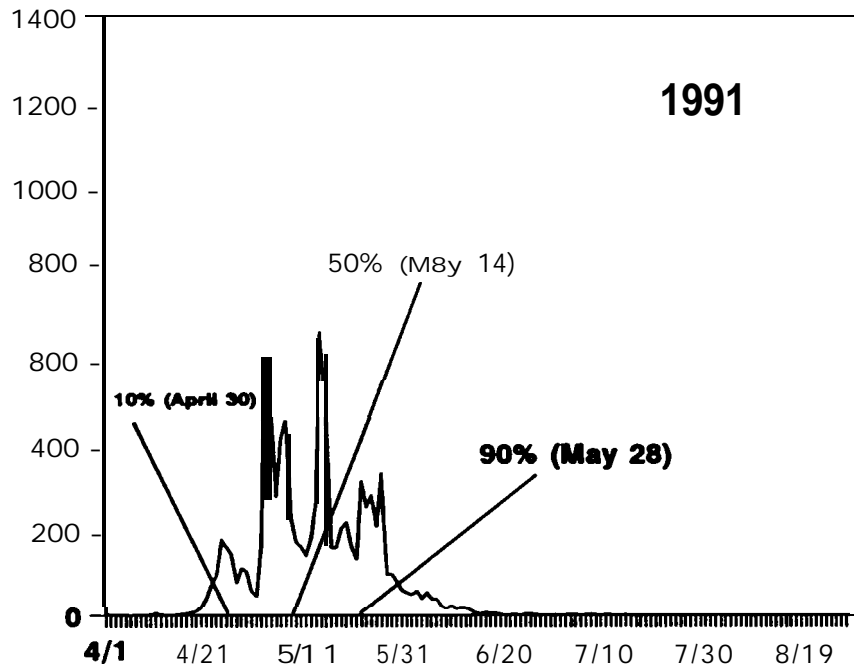
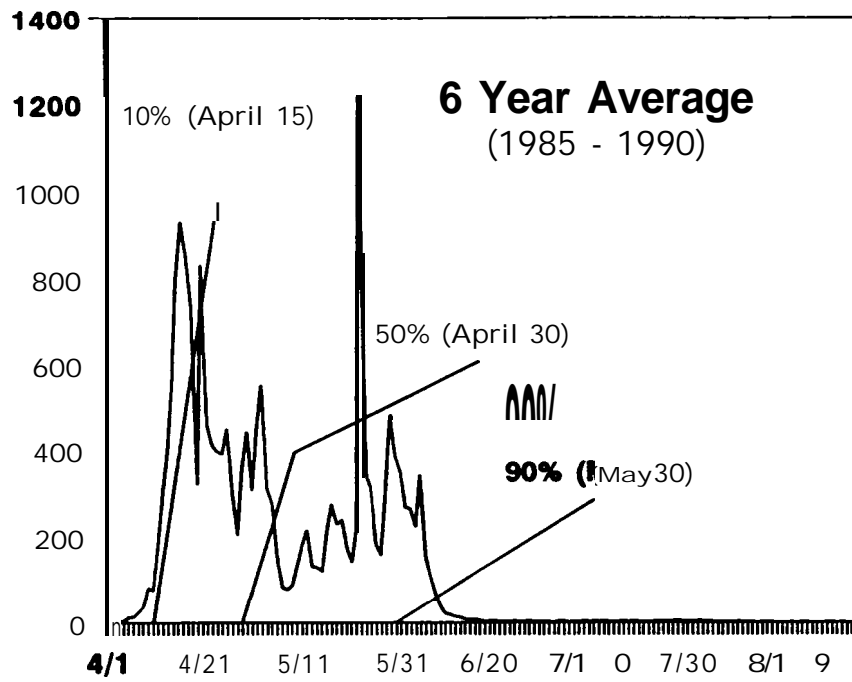
Appendix B-3. Steelhead juvenile run timing, Rock Island Dam, 1991 and the 6 year average.

Numbers of Fish/day



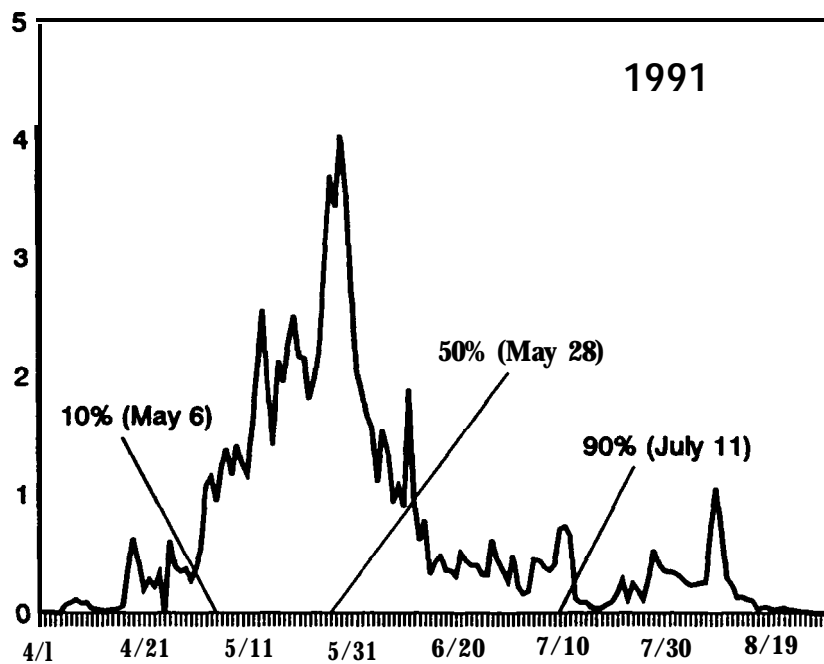
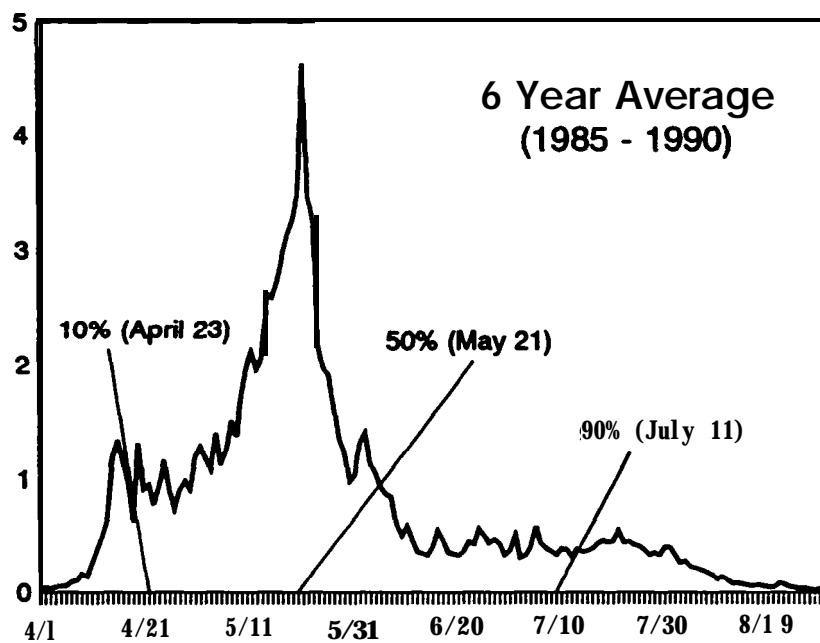
Appendix B-4. Coho juvenile run timing, 1991 and the 6 year average.

Numbers of Fish/day



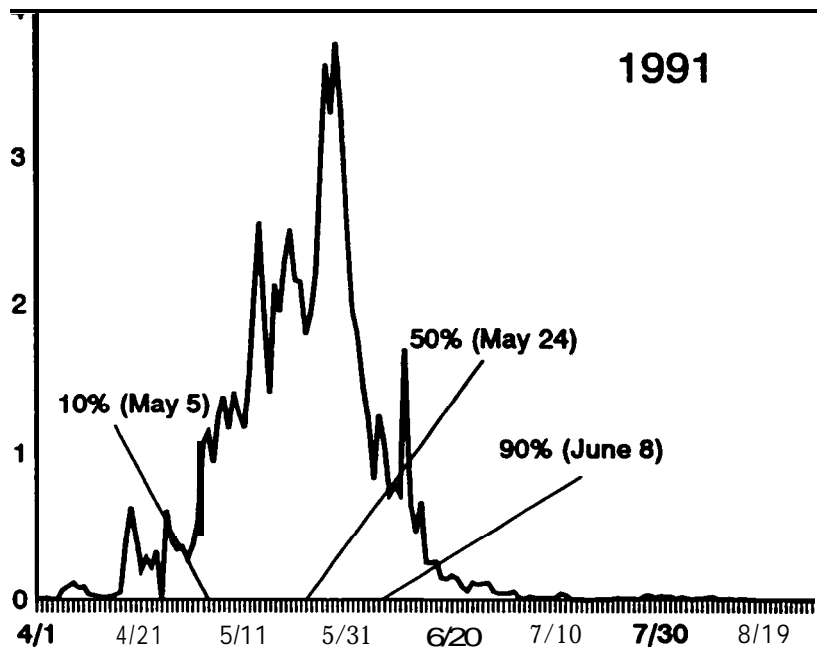
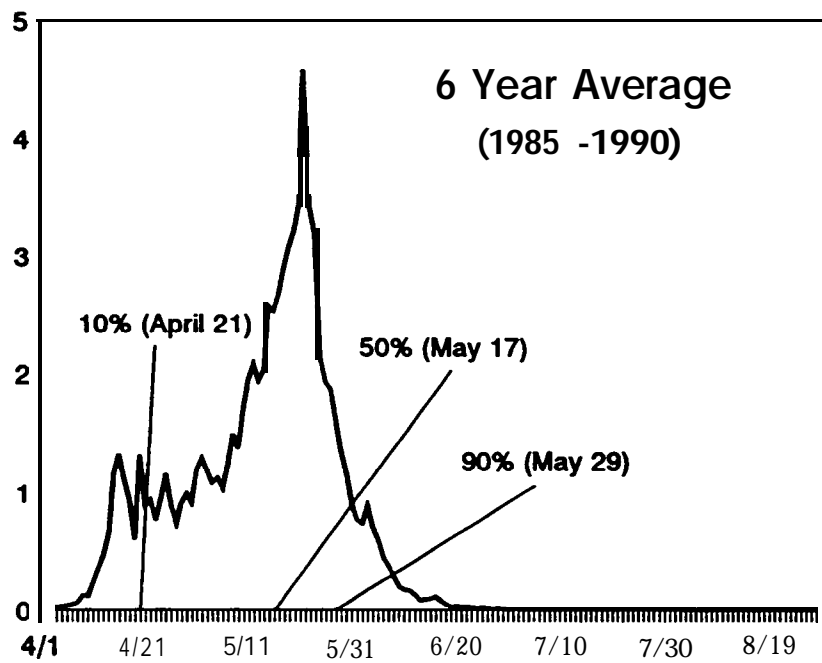
Appendix B-5. Sockeye juvenile run timing, 1991 and the 6 year average.

Numbers of Fish (1°00's)



Appendix B-6. Total salmonid juvenile run timing, Rock Island Dam, 1991 and the 6 year average.

Numbers of fish (1000's)



Appendix B-7. Total yearling juvenile run timing, Rock Island Dam, 1991 and the 6 year average.